MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018 / 2019

ECE3296 – DIGITAL IMAGE AND VIDEO PROCESSING

(CE, ME)

23 OCTOBER 2018
2.30 p.m. - 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **SEVEN** printed pages with **FOUR** questions.
2. Answer **ALL** questions.
3. Write your answers in the Answer Booklet.

Question 1

(a) Figure Q1 shows the fundamental steps involved in digital image processing system. Briefly explain the following components:

i. Pre-processing
ii. Segmentation
iii. Representation and description
iv. Recognition and interpretation
v. Knowledge base

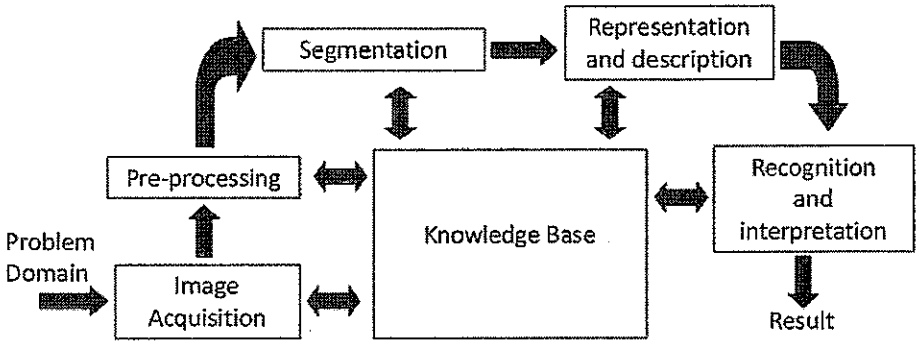

Figure Q1

[10 marks]

(b) Explain the following optical illusions phenomenon:

i. Machband effect
ii. Simultaneous contrast

[5 marks]

(c) Sampling and quantization are two main processes in the production of digital images and video. Explain the sampling and quantization processes, and how it relates to image quality in terms of image resolution and number of bits.

[6 marks]

(d) Image subtraction is often used in industrial applications for detecting missing components in product assembly. Suggest a simple image-based system to detect missing components utilizing image subtraction.

[4 marks]

Continue...

Question 2

(a) Each pixel of a given image at location (x,y) is transformed as:

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 & 0.5 & 10 \\ 0 & 3 & -15 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

i. Describe all transformations involved based on the transformation matrix above.

[5 marks]

ii. Suggest the changes to the transformation matrix if the image is to be rotated by an angle θ.

[2 marks]

(b) Figure Q2(a) shows some basic intensity transformation function for gray level images. Referring to the function, describe what would happen to an image if they are transformed with the following functions:

i. Negative transformation
ii. Log transformation

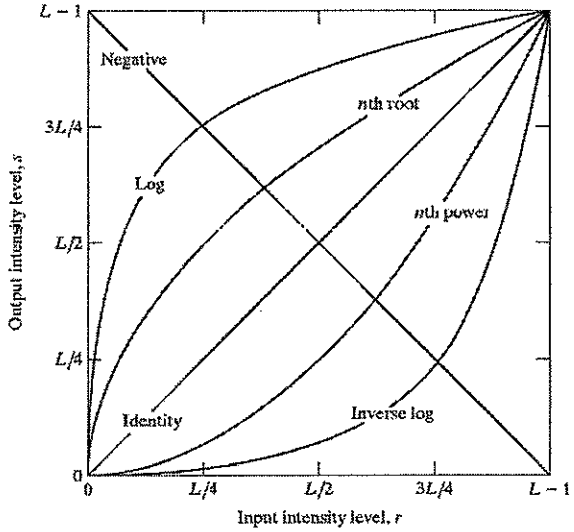

Figure Q2(a)

[5 marks]

Continue...

(c) Figure Q2(b),(c) and (d) shows three types of filters commonly used in spatial filtering. For each filter, specify the filter type and explain the output generated from these filters.

$1/9$	$1/9$	$1/9$
$1/9$	$1/9$	$1/9$
$1/9$	$1/9$	$1/9$

Figure Q2(b)

-1	-1	-1
-1	8	-1
-1	-1	-1

Figure Q2(c)

-1	-2	-1
0	0	0
1	2	1

Figure Q2(d)

[6 marks]

(d) For the following 3 bits 4×4 image:

i. Plot the histogram of the image.
ii. Apply histogram equalization on the image.
iii. Show the histogram-equalized image.
iv. Plot the equalized histogram.

4	1	3	2
3	1	1	1
0	1	5	2
1	1	2	2

[7 marks]

Continue...

Question 3

(a) An image with 3-dimensional feature space as shown in Figure Q3(a) is to be segmented using k-means clustering technique.

i. Suggest a suitable value of k. Justify your answer.

ii. If the segmentation is based on color, suggest possible features that make up the 3-dimensional feature space in Figure Q3(a).

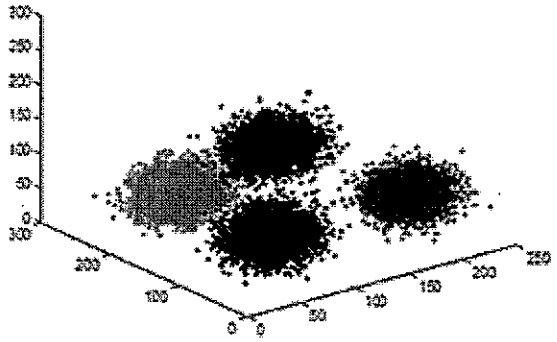

Figure Q3(a)

[5 marks]

(b) Gray-level co-occurrence matrix is a statistical method of examining texture that considers the spatial relationship of pixels.

i. For the 8×8 binary checkerboard image in Figure Q3(b), construct the co-occurrence matrices for displacements $\mathbf{d} = (0,1)$, $\mathbf{d} = (1,0)$, $\mathbf{d} = (1,1)$ and $\mathbf{d} = (1,-1)$.

[8 marks]

ii. List down 4 features that can be calculated from co-occurrence matrices to represent textured images.

[2 marks]

1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1

Figure Q3(b)

Continue...

(c) Minimum distance classifier is a simple and fast classifier that classifies an object based on the distance between the object's features with each class mean vector, or centroid. But difficulties can arise when the structure of class samples is complex, such as the one shown in Figure Q3(c) (2-dimensional feature space for a 4-class recognition problem).

i. Explain the problems encountered by minimum distance classifier for the example shown in Figure Q3(c).

ii. Suggest how the problems you discussed in (i) can be addressed.

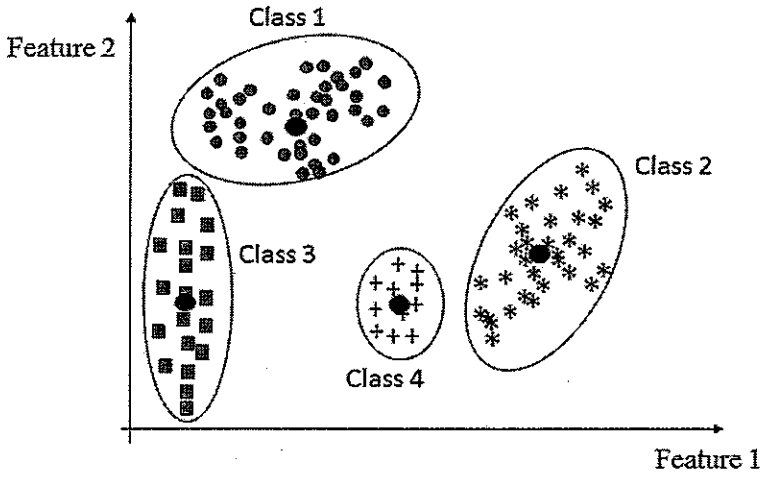

Figure Q3(c)

[6 marks]

(d) In an image retrieval system, suppose an image database contains 750 images of buildings that would be of interest to the user and that the user hopes will match the query. Suppose the system retrieves 600 of those 750 relevant images and 200 other images (non-building) that are of no interest to the user. Calculate the precision and recall rate for this system.

[4 marks]

Continue...

Question 4

(a) Explain, with the aid of a diagram, the process of digital video formation.

[6 marks]

(b) Figure Q4(a) shows a video sequence. Frame C is obtained from the interpolation of Frame A and Frame B for the frame-up conversion purpose.

i. Based on the generated content, suggest the frame-up conversion method that has been applied to obtain Frame C. What is the limitation of this method?

[4 marks]

ii. Suggest a better way to improve the method that you described in Part i).

[4 marks]

Frame A Frame B Frame C

Figure Q4(a): A video sequence

(c) A video sequence is shown in Figure Q4(b). Perform 3-to-2 pull down method on the video sequence for frame rate up conversion. State one disadvantage of this method.

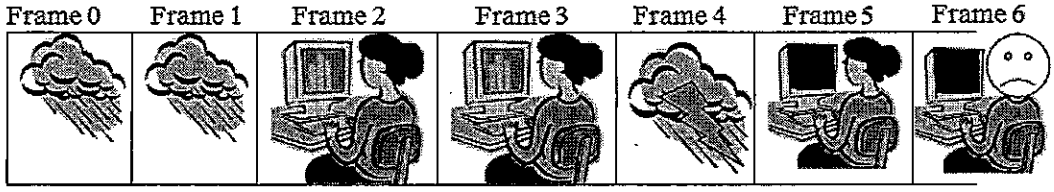

Figure Q4(b)

[5 marks]

(d) Describe the *optical flow* method in segmenting multiple moving objects using motion segmentation.

[6 marks]

End of paper